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RELATION OF MOISTURE CONTENT TO QUALITY OF VANILLA BEANS

by

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INTRODUCTION

Vanilla beans undergo during curing a series of chemical transformations which lead to the formation of flavoring compounds. (*1, 3*). Curing consists usually (*5, 6, pp. 84-117, 7*) of an initial killing or wilting treatment which arrests the natural vegetative processes and hastens chemical changes. After this treatment, the beans are usually subjected to heating and subsequent sweating in blankets or else continuous heating. The process is completed by further partial drying at room temperature and finally aging or conditioning in wooden boxes.

Curing is accompanied by a loss of moisture which starts during sweating and continues throughout the drying and conditioning periods. The moisture left in the beans influences their appearance and flexibility. A relatively high percentage of moisture is desirable and produces higher returns as the beans are sold by weight. It is of importance, therefore, that the curer of vanilla controls moisture losses during curing.

Figure 1 shows some of the visible differences between freshly harvested and cured beans of *Vanilla fragrans* (Salisb.) Ames, the vanilla of commerce.

(1) Formerly Assistant Plant Pathologist and Physiologist of this Station and now Agriculturist in the Office of Foreign Agricultural Relations, assigned to Nicaragua.

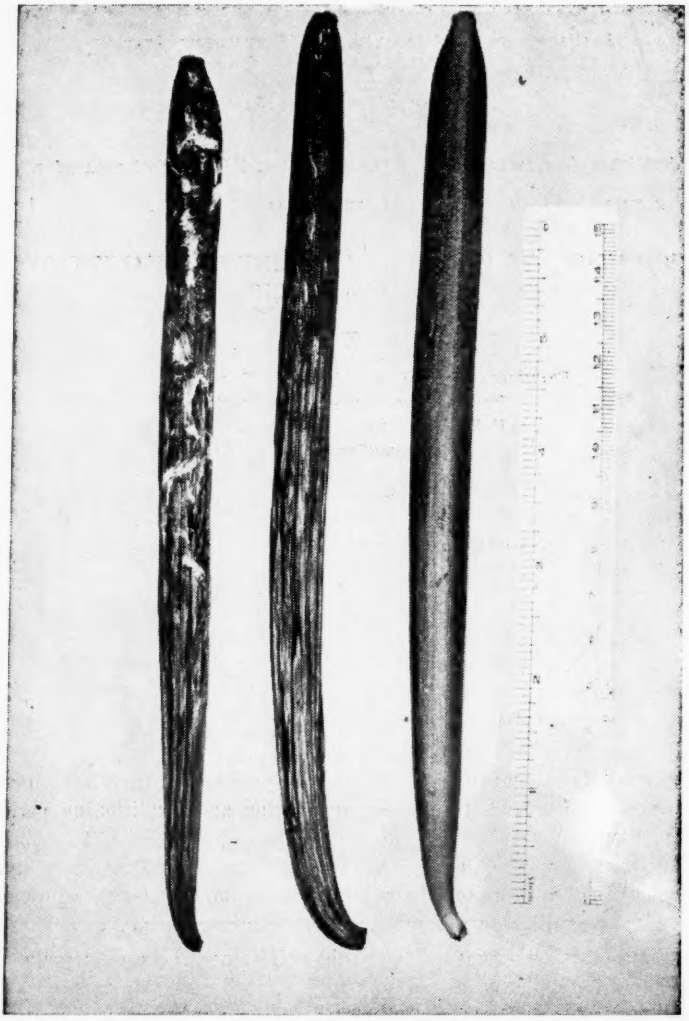

Figure 1. Vanilla beans; one at left, freshly harvested and two at right cured. The white marks on the surface of the cured bean at the extreme right are crystals of vanillin, the most widely known of the aromatic constituents of vanilla.

Moisture Content of Uncured Beans

Maturation is indicated in uncured vanilla beans by the development of a yellow coloration at the blossom-end. As ripening increases, this coloration spreads along the entire bean and is often accompanied by longitudinal splitting. Fully mature beans finally acquire a chocolate color.

Analyses were made to determine variations in moisture content of beans of different maturities. Beans 6.5 to 7.5 inches in length, harvested about 5 days previously, were graded according to maturity as whole beans, entirely green; whole, blossom-end yellow; split, blossom-end yellow; and split, entirely chocolate. From each grade of beans three random samples were selected. Moisture determinations were made by vacuum oven-drying at 68° to 70° C. at 100 mm. pressure. (*2, p. 336*)

Whole beans, entirely green were found to have an average moisture content of 81.2 percent, whole beans with blossom-ends yellow 79.2; split beans with blossom-ends yellow 79.0, and split beans all chocolate 73.5. The moisture content of split beans varies to a large degree with the extent and time of splitting. The percentage of moisture in the beans thus decreased with maturity.

Losses in Weight During Curing

A study was made of vanilla beans subjected to different killing treatments to determine whether a significant weight loss other than that due to loss of water occurs during the chemical transformations which take place during curing.

The beans used were 6.5 to 7.5 inches long and were at different stages of maturity. The treatments consisted of freezing for 4 and 20-hour periods, three 10-second immersions at 30-second intervals in water heated to 80° C., exposure to ethylene gas for different periods at a concentration of 1 part to 10,000 parts of air, rubbing with alcohol, exposure to the sun, and placing in an oven at 65° C. These treatments, which were applied singly and in combination, were followed by sweating in an oven or in the sun, further drying on racks at room temperature to the desired loss in weight, and conditioning in closed wooden boxes for 3 months. The loss in weight of the beans during curing was recorded and the amount of moisture in the final, cured beans was determined. The results classified according to maturities and the killing treatments used, are shown in table 1.

Table 1. Loss in weight and moisture content of vanilla beans of five stages of maturity during curing after various killing treatments (1)

Killing treatment	*Total loss in weight during curing*	*Moisture content of cured beans*	*Loss in weight during curing plus moisture left in cured beans (2)*
	PERCENT	PERCENT	PERCENT
WHOLE BEANS, BLOSSOM-END GREEN			
Frozen for 4 hours	74.2	26.6	81.1
Frozen for 20 hours	72.7	28.8	80.6
Frozen for 4 hours; hot water	72.8	26.8	80.1
Hot water; frozen for 4 hours	72.5	26.5	79.8
Hot water	75.6	20.4	80.6
Rubbed with alcohol; hot water	72.2	26.9	79.7
Ethylene gas for 4 14-hour periods	76.0	20.3	80.9
Ethylene gas for 14 hours	75.1	19.8	80.0
WHOLE BEANS, BLOSSOM-END YELLOW			
Frozen for 4 hours	72.9	27.9	80.5
Frozen for 20 hours	70.2	27.8	79.0
Frozen for 4 hours; hot water	72.3	26.1	79.5
Hot water; frozen for 4 hours	72.1	28.5	80.1
Hot water	75.6	20.7	80.7
Rubbed with alcohol; hot water	71.4	26.7	79.0
Ethylene gas for 4 14-hours periods	74.9	21.3	80.3
Ethylene gas for 14 hours	74.1	20.1	80.0
SPLIT BEANS, BLOSSOM-END YELLOW			
Ethylene gas for 4 14-hour periods	73.4	20.8	78.9
Ethylene gas for 14 hours	73.6	21.1	79.2
SPLIT BEANS, BLOSSOM-END CHOCOLATE			
Hot water	70.2	20.6	76.3
Ethylene gas for 4 14-hour periods	73.7	20.4	79.1
Ethylene gas for 14 hours	71.4	21.7	77.6
SPLIT BEANS, ALL CHOCOLATE			
Sun	68.8	19.6	74.9
Oven at 65° C.	69.4	19.8	75.5

(1) Three- to 4-pound lots of beans were used in each treatment, except in split beans, all chocolate, in which 2-pound lots were used.

(2) Calculated by adding the total loss in weight during curing to the water present in the remaining percent weight of cured beans. These figures represent approximately the average moisture content of these types of uncured beans. Thus weight loss in curing, other than that due to loss of water, was negligible.

It can be observed in table 1 that regardless of the killing treatment and the final moisture content of the cured beans, the total loss in weight during curing plus the water present in the cured product was from 79.7 to 81.1 percent of the original weight for whole green beans, and from 79.0 to 80.7 percent of the original weight for blossom-end-yellow beans. These figures represent approximately the average moisture content of these types of uncured beans, as stated previously. In the blossom-end chocolate split beans the values for the losses in weight during curing plus the moisture of the cured beans showed greater variation. However, this is to be expected inasmuch as the extent of splitting and the degree of maturation of these types cause appreciable variations in the moisture content. Therefore, it can be concluded that weight loss, other than that due to loss of water, was negligible.

Loss in Weight During Conditioning

Moisture losses in curing vanilla occur principally during the sweating and drying treatments. Weight losses also occur during the conditioning or

Table 2. Losses in weight on a fresh basis in vanilla beans during the conditioning period (1)

At the end of drying	*During the first 3-month period of conditioning (2)*	*During the second 3-month period of conditioning (2)*
PERCENT	PERCENT	PERCENT
75.8	− 0.2	− 0.2
75.3	.2	.1
72.3	.8	− .3
72.2	1.7	.3
72.1	.1	.0
71.2	1.2	.1
70.9	2.0	− .4
70.5	3.1	.6
70.4	2.3	− .4
70.3	2.5	.4
70.0	1.7	.6
69.8	2.7	− .2
69.8	1.9	.3
69.4	3.5	.6
69.4	2.0	.3
69.3	1.8	.3
68.9	2.9	.9
67.8	4.5	1.1
66.6	3.4	.9
63.3	6.7	1.0
62.0	5.9	1.3

(1) Three-pound lots of whole beans with blossom-end either green or yellow were used.
(2) A negative loss of weight signifies an actual gain.

final phase of the processing during which vanillin crystallizes on the surface of the beans and the characteristic vanilla aroma gradually develops.

The moisture losses during the conditioning treatment in 21 3-pound lots of beans were determined. These samples had lost from 62.0 to 75.8 percent of their weight at the end of the drying period. The beans were weighed before being placed in the conditioning boxes and at the end of 3 and 6 months. The data are listed in table 2.

As shown in table 2, there was an appreciable loss in weight in most of the lots during the first 3 months of conditioning, ranging from a gain of 0.2 to a loss of 6.7 percent. The loss in weight was negligible, however, during the last 3 months not reaching in any case more than 1.3 percent. It is apparent that moisture content approached an aquilibrium during conditioning and that the loss in weight during this period was generally greatest in the beans containing the most moisture.

Nomograph for Moisture Calculations

A nomograph is given in Figure 2 showing the weights to which 100-pound lots of beans of different moisture contents should be reduced during curing to obtain a predetermined moisture content in the end-product.

Example: To cure100 pounds of green beans to a desired final moisture of 30 percent, assuming or knowing 80 percent moisture content of fresh beans, run a straight line from point 80 on left axis to point 30 on right inclined axis. Read off on center axis final weight of beans after curing, including conditioning. To obtain the weight to which the beans should be dried before conditioning, the loss during conditioning should be added to that obtained from the chart. The loss during conditioning depends principally upon the moisture content of the beans at the beginning of conditioning, the number and length of times the beans are examined, and the amount of wiping to remove molds. However, for approximate purposes, the following losses may be assumed: For30-40 percent final moisture in the cured product, 4-7 pounds of 100 pounds fresh and for 20 to 30 percent moisture, 1-3 pounds.

Evaluation of Cured Beans with Different Moisture Contents

An experiment was conducted to determine the variation in physical characteristics, phenol value including vanillin (4), and aroma of vanilla beans cured by different procedures to varying moisture contents. Data are shown in table 3.

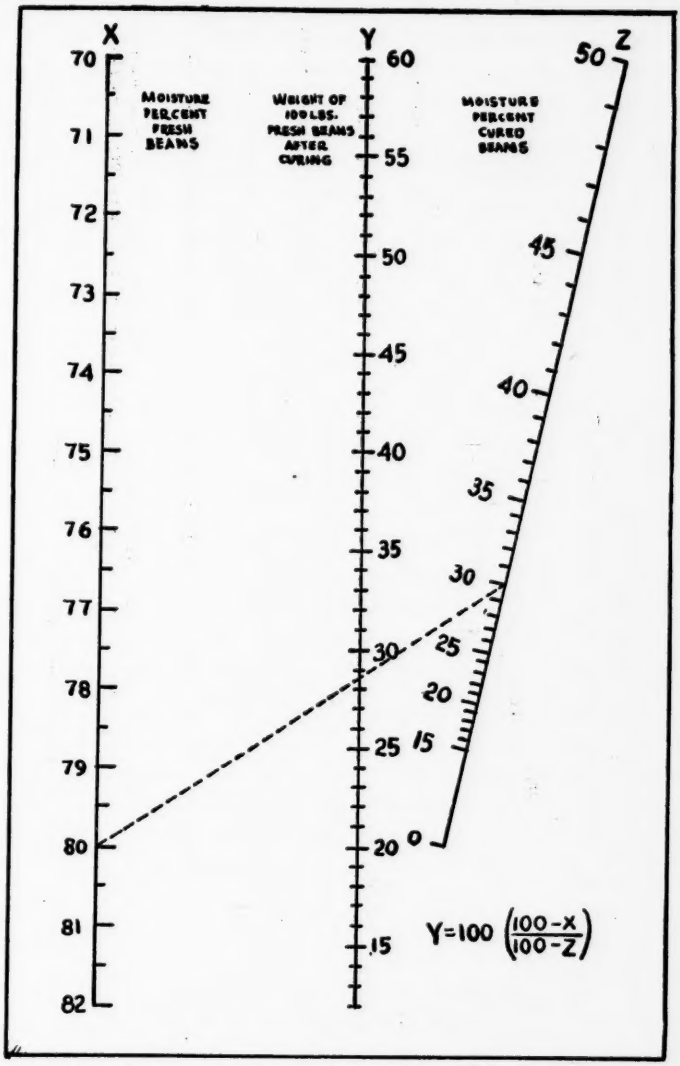

Figure 2. Nomograph relating the three variables: X=moisture content of fresh vanilla beans in percent fresh basis, Y=weight to which each 100 lbs. should be reduced during curing, and Z=moisture content of cured beans in percent cured weight basis. See example given in the text.

Table 3 Evaluation of vanilla beans cured to different moisture contents (1)

Killing treatment (2)	*Final moisture content*	*Chocolate color*	*Degree of flexibility*	*Vanillin crystals*	*Mold development* (3)	*Phenol value dry basis*	*Aroma*
	PERCENT				PERCENT	PERCENT	
Hot water	26.5	Dark	Medium	Few	0.0	6.3	Developed, suave
Hot water	30.7	Dark	Very	None	0.0	6.3	Developed, not suave
Hot water	49.9	Light	Very	None	0.0	6.4	Crude, slightly fermented, not suave
Freezing	26.2	Reddish	Very	Some	0.0	6.8	More developed, suave
Freezing	32.6	Reddish	Very	None	0.0	6.7	Developed, very suave
Freezing	50.5	Light	Very	None	0.0	6.9	Developed, slightly fermented, suave
Sun	26.5	Dark	Medium	None	0.0	6.7	More developed, suave
Sun	30.9	Light	Very	None	4.0	6.3	Developed, suave
Sun	53.0	Light	Very	None	7.0	6.9	More developed, slightly fermented, not suave
Ethylene	24.2	Dark	Little	Few	0.0	7.3	More developed, suave
Ethylene	33.6	Light	Medium	Few	3.0	7.5	More developed, suave
Ethylene	54.3	Light	Very	None	3.0	6.9	Developed, slightly fermented, not suave

(1) Beans killed by hot water and freezing were obtained from the same batch and beans killed by sun and ethylene from another batch.

(2) Beans killed by hot water, freezing and ethylene were oven-sweated and beans killed in the sun were also sun-sweated. All the lots were then dried further at room temperature to the desired loss in weight and conditioned for 3 months.

(3) Beans examined for mold at periods varying from 4 to 9 days.

As can be observed in table 3, the moisture content of the beans affected the physical appearance and aroma of the beans in each of the different curing treatments but did not produce any significant effect in the phenol value.

In all treatments, beans with moisture contents varying from 50 to 54 percent, had a fermented aroma generally lacking suavity and development. Beans containing 24 to 27 percent moisture had a more developed and suave aroma but little flexibility while beans with 31 to 34 percent moisture had a well developed and suave aroma and also possessed a high degree of flexibility.

Beans with lower moisture content were generally darker in color and as expected their vanillin crystallization was greater except in the sun-cured beans in which no crystals appeared. The beans killed by freezing were characterized by great flexibility even when their moisture content was low and had a reddish color.

No appreciable molding occurred in any of the treatments when the beans contained 24.2 to 26.5 percent moisture nor in the beans subjected to hot water or freezing having 30.7 to 50.5 percent moisture. Beans subjected to the ethylene and sun-killing procedures developed more mold than did those subjected to hot water or freezing. This may be due to the fact that in the former procedures the beans were not as thoroughly and uniformly killed. The effectiveness of the killing treatment is usually evidenced by a change in coloration which takes place in the beans during the sweating period or exposure to heat. The beans killed in hot water and by freezing became dark brown in color after a shorter period of sweating in electric ovens at 45°C., than the ethylene and sun-treated beans. Moreover, freezing and hot water treatment may have a sterilizing effect in the beans.

Moisture Content of Foreign Beans

Moisture contents were determined of several samples of beans from Mexico, Comores, Tahiti, Madagascar, and Guadeloupe, which are among the most important vanilla-producing countries of the world. Results are shown in table 4.

Table 4. Moisture content of cured vanilla beans from different countries

Source	*Moisture content*
	PERCENT
Mexico	40.3
Mexico (1)	38.3
Comores	35.4
Tahiti	37.5
Tahiti (1)	33.4
Madagascar	31.3
Guadeloupe (1)	17.8
Guadeloupe	15.2

(1) The moisture contents of these beans were determined several months after receipt.

As can be seen in table 4, the moisture content was over 30 percent in the beans of all the countries except those of Guadeloupe.

SUMMARY

The moisture content of uncured vanilla beans was found to decrease with maturity. The average value obtained for whole beans entirely green was 81.2 percent and for whole, blossom-end yellow 79.2 percent. The moisture of split beans varied to a large degree with the extent and time of splitting.

Losses in weight in vanilla beans, other than those due to loss of moisture, were shown to be negligible during the curing process, regardless of the procedure used.

Although the greatest loss in weight in the beans occurred during the sweating and drying periods, a significant loss in weight also occurred during the first 3 months of the conditioning period. Moisture losses during conditioning were greater for beans of higher moisture content.

A nomograph is included showing the weights to which 100-pound lots of beans of different moisture contents should be reduced during curing to obtain a known moisture content in the end-product.

Moisture content was found to affect the appearance and aroma of the beans but did not produce any effect in the phenol value. Beans cured by different procedures with a moisture content of over 50 percent had a fermented aroma generally lacking suavity and development. Beans with 24 to 27 percent moisture had a more developed and suave aroma but little flexibility while those with 31 to 34 percent had well-developed and suave aroma and good flexibility. Beans with similar moisture content, sub-

jected to hot-water or freezing treatments were found to be less liable to mold infection than sun or ethylene-treated beans.

Commercial lots of vanilla beans from Mexico, Madagascar, Comores, and Tahiti were found to contain over 30 percent moisture.

Puerto Rican vanilla beans should be cured to a final moisture content of 30 to 35 percent if good flexibility and development and suavity of aroma, which are the principal factors affecting the sales value are to be obtained, judging from the results of our experiments.

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THE VALUE OF UTILIZING EXISTING SHADE IN THE GROWING OF VANILLA

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Vanilla grew more rapidly on underbrushed land with existing shade than on cleared land with replanted shade.

The customary practice in the early plantings of vanilla in Puerto Rico was to clear the land and plant trees, such as the dwarf bucare (*Erythrina berteroana* Urban), for shade and support. This resulted in a delay of 1 or 2 years before actual planting of the vanilla could be made. From observations and trial it was found that many varied trees could be used as supports for vanilla and that usually the trees already on the land and producing shade were entirely adequate. Under this method planting can be started immediately, and by utilizing existing facilities, costs can be much reduced.

In 1937, a parcel of land on the grounds of the Puerto Rico Experiment Station at Mayagüez was prepared by clearing all trees and underbrush from one-half of the area and only the underbrush from the remainder. Both portions were planted with support stakes of dwarf bucare. On October 25, 1939, when the bucare in the completely cleared portion had grown sufficiently to afford proper shade, 100 8-node vanilla cuttings of uniform size and vigor were planted in both areas.

Root formation was superior on vines under existing shade.

A record of the number of roots formed on the cuttings in each treatment was made every second month for 1 year, as shown in table 1.

(1) In cooperation with the Government of Puerto Rico.

Table 1. Cumulative root formation found on vanilla cuttings at bimonthly intervals after planting at the base of support trees on cleared land and on underbrushed land on October 25, 1939.

Treatment	*Roots formed*					
	Dec. 26	Feb. 26	Apr. 26	June 26	Aug. 26	Oct. 26
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Planted on cleared land	247	222(1)	154(1)	135(1)	127(1)	121(1)
Planted on land with existing shade	409	419	426	433	436	426(1)

(1) Decrease in number of roots was due to decay of some roots previously formed.

It is evident that the vines planted under existing shade produced the greater number of roots throughout the experiment. The root formation of the vines planted under existing shade, was over thrice as great as that of the vines planted on cleared land, and the rotting of newly formed roots was considerably delayed. This decay can probably be accounted for by the quality of the shade provided by the existing trees as compared to the limited shade provided in the cleared area by the bucare support trees.

Amount of seed-piece rotting was considerably less on vines under existing shade.

The information gathered regarding seed-piece deterioration is summarized in table 2.

Table 2. Extent of seed-piece rotting.

Treatment	*Decayed seed-piece internodes*					
	Dec. 26	Feb. 26	Apr. 26	June 26	Aug. 26	Oct. 26
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Planted on cleared land	5.0	13.7	38.0	53.4	59.1	61.0
Planted on land with existing shade	1.6	1.6	2.1	3.3	4.4	6.8

As can be observed for table 2, of the vanilla cuttings planted, 61.0 percent developed stem rot on cleared land, while under existing shade only 6.8 percent were so affected. The greatest amount of stem rotting occurred during the dry season; at this time of the year the bucare supports shed their leaves and consequently many of the vanilla cuttings were exposed to direct sunlight, which apparently favored stem rotting.

Amount of vegetative growth was superior in vines under existing shade.

Data on the amount of vegetative growth are shown in table 3.

Table 3. Vegetative growth of vanilla vines planted on cleared land and on land with existing shade, October 25, 1939.

Treatment	*Average stem growth per cutting*					
	Dec. 26	Feb. 26	Apr. 26	June 26	Aug. 26	Oct. 26
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Planted on cleared land	2.76	7.32	10.96	16.84	26.26	21.41
Planted on land with existing shade	3.55	4.96	7.35	16.77	32.51	53.42

During the early part of the experiment, the amount of vegetative growth per plant on vines planted on cleared land was somewhat greater than that on the vines under existing shade. Vegetative growth per plant by June, 8 months after planting, was about equal for both treatments. From August to October, which period composes part of the rainy season in this district, the plants grown under existing shade greatly surpassed the other planting. It is evident that the amount of vegetative growth per plant was over twice as great as that of the vines grown on cleared land.

The total amount of vegetative growth of the cuttings together with the root germination and rotting of the seed pieces per treatment is shown graphically in figure 1.

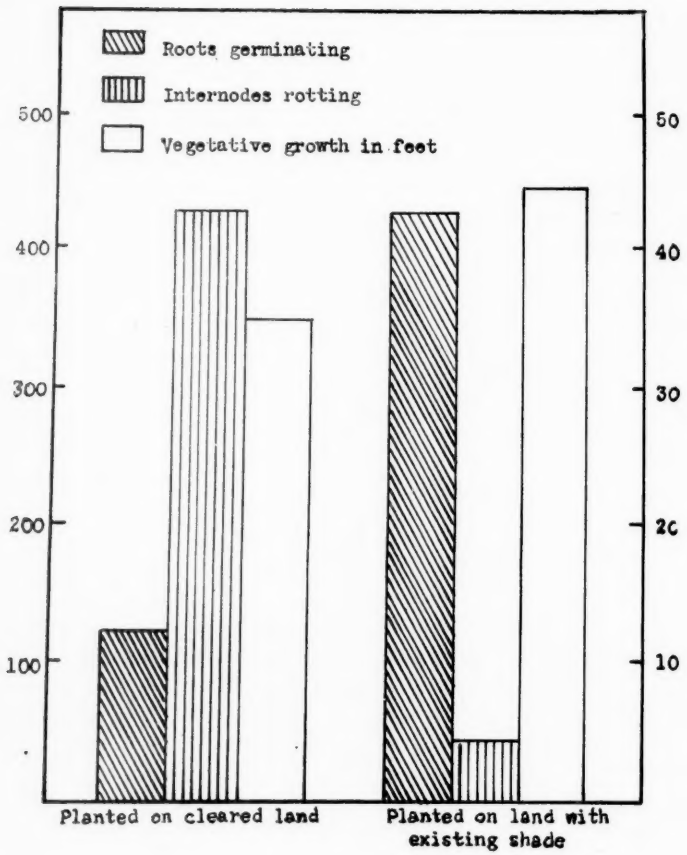
Roots germinating
Internodes rotting
Vegetative growth in feet
500
400
300
200
100
50
40
30
20
10
Planted on cleared land
Planted on land with existing shade

Figure. 1.

Character of vine growth under existing shade was distinct from that on cleared land.

From the beginning of the experiment it was observed that the internodes of the vines under existing shade were rather thin and long, as illustrated in figure 2, as compared to the short and thick internodes of the vines on cleared land, as shown in figure 3. The color of the former was dark green, characteristic of healthy normal plants, while that of the latter was an unhealthy yellow. This undesirable color of the vines on cleared land was doubtless due to excessive exposure to the sun's rays, intensified by the bucare supports shedding their leaves during the dry season.

This experiment clearly supports other observations that vanilla vines can be planted to advantage on land with existing shade with only a minimum amount of clearing. Furthermore, the planting can take place immediately after land preparation; eliminating a delay of from 1 to 2 years until the support trees have developed sufficient shade to protect the plants. Although bucare was used as a support in this experiment, it is now known that vanilla vines can be planted on available existing shade trees most of which serve the same purpose with equal satisfaction.

Figure 2. Character of vine growth of *Vanilla fragrans* vine planted on underbrushed land. Note the long, thin internodes. The leaves were long, narrow, and of a healthy dark-green color.

Figure 3. Character of growth of *Vanilla fragrans* planted on cleared land. Note the short, thick internodes. The leaves were short, thick, wide, cupped, and rather yellow due to excessive exposure to sun rays, intensified by the leaf shedding of the bucare supports during the dry season.

SUMMARY

When vanilla was grown on bucare supports under existing shade it produced more root germination, less seed-piece rotting, and more vegetative growth than when grown on the same kind of support trees on cleared land. The differences between the two groups of vines were considerable. The vines under existing shade were of a dark-green color characteristic of healthy normal plants as compared to the yellowish color of the vines grown on cleared land. Because of the nature of dwarf bucare to shed its leaves during the dry season, at the time when the vanilla plant needs shade, it would be preferable to use this support, where needed, only under natural or existing shade.

Acknowledgement

The writer wishes to express his appreciation of valuable suggestions during the procedure of the experiment received from Dr. Arthur G. Kevorkian, former assistant plant pathologist and physiologist in charge of vanilla investigations.

PRELIMINARY NOTE ON THE ADMINISTRATION OF NON-CONDITIONED PHENOTHIAZINE, IN SMALL DAILY DOSES, FOR THE CONTROL OF GASTROINTESTINAL PARASITES OF CATTLE IN PUERTO RICO [1]

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INTRODUCTION

Shorb and Habermann (1940) reported that the presence of one per cent by weight of phenothiazine in the feces of sheep would prevent the development of nematode larvae and that .5 gram of this compound per day administered in the feed would inhibit the development of all nematode larvae in the feces of these animals except those of *Strongyloides papillosus*. Habermann and Shorb (1942) confirmed these findings in an experiment involving the voluntary ingestion of mixtures of phenothiazine and salt by infected sheep.

Cattle in Puerto Rico are commonly infested with a number of different species of gastrointestinal parasites. Since the scarcity of available clean pasture prevents the use of pasture rotation as a means of controlling these infestations, it was considered desirable, in view of the favorable results obtained by Shorb and Habermann (loc. cit.), to determine the effect of the frequent administration of small doses of phenothiazine over a long period of time on the cattle and on the parasites harbored by them.

MATERIALS AND METHODS

Three herds of cattle on widely separated farms located on the north coastal plain of Puerto Rico were selected for these experiments. Herd 1

(1) Published by permission of the Director of the Agricultural Experiment Station of the University of Puerto Rico, Río Piedras, P. R.

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was made up of 22 animals, 4½ to 24 months old, which normally grazed a relatively low-lying malojillo grass pasture, but were fed in addition chopped sugar cane trash or grass cut from a neighboring field, whichever was available at the time. Herd 2 was composed of 12 animals, 8 to 28 months old, which were kept in a feed lot containing some vegetation, but were fed chopped grass cut from a field used only for furnishing this type of feed. Herd 3 consisted of 15 animals, 7 to 11 months old, which were fed chopped grass, sugar cane trash, and concentrates. Some of the animals in the latter group were allowed to graze low-lying malojillo grass pasture.

The number of parasite eggs per gram of feces was first ascertained for each animal and the different species of parasites harbored by the animals was ascertained by noting the kinds of worm eggs present in the feces. Herds 1 and 2 were each divided into two equal groups in such a way that each group was passing approximately the same number of parasite eggs per gram of feces. Group 1 and Group 2 of Herd 1 were separated by a fence dividing the pasture originally occupied by the whole herd. Group 1 received ½ gram of nonconditioned phenothiazine per day per 100 pounds of live weight for 105 days. The compound was given in # 00 white gelatine capsules administered by means of a balling gun. Group 2 remained untreated as a control. At the end of the 105-day period, the treatment of Group 1 was discontinued and the treatment of Group 2 was begun at the same dose rate. The experiment was then continued for 69 days and was terminated because of the flooding of the pasture.

The two groups of Herd 2 were not separated from each other. Group 1 of this herd received phenothiazine in white gelatine capsules at the same dose rate as the animals belonging to Herd 1, but the compound was administered at weekly intervals. Group 2 of Herd 2 remained untreated as a control. Treatment was discontinued entirely at the end of 77 days, although the number of eggs per gram of feces was ascertained in both groups for an additional 89-day period.

Herd 3 was not separated into two groups. All of the animals in this herd received daily doses of phenothiazine mixed in the ground concentrate portion of their daily ration. These doses were equivalent to those received by the animals in Herd 1. Data on this herd were recorded for 175 days.

The animals belonging to Herd 1 were weighed at the beginning and at the end of the experiment. A weighing tape was used to estimate the weights of the animals at approximately weekly intervals during the

experiment. The same tape was used in estimating the weights of the animals in Herd 2. The animals in Herd 3 were weighed on a scale at monthly intervals.

Determinations of the number of parasite eggs per gram of feces were made on all animals at the intervals indicated in Figure 1, and the data recorded. No autopsies were made.

Data obtained

Nine animals from Herd 1, six from Herd 2, and nine from Herd 3 were very lightly infested at the beginning of the experiment, and passed so few worm eggs that the data were not included in this paper. Observations on one other calf were also omitted because the findings were not comparable to those obtained on the remaining animals. Data from 24 animals are recorded in Figure 1.

The average number of parasite eggs per gram of feces for six animals of each group belonging to Herd 1 are given in Graph A of Figure. 1. These data show that the number of parasite eggs in the feces of the treated calves dropped markedly within one week from the beginning of treatment, while that of the control calves remained at a relatively high level for approximately two months. The drop in the egg count of the untreated calves which then occurred was probably due to the feeding of chopped sugar cane trash which may have decreased the rate of reinfection. When phenothiazine was administered to the previously untreated Group 2, the number of parasite eggs per gram of feces dropped to a very low level for the remainder of the experiment. The effect of discontinuing the treatment of Group 1 was not noticeable until about two months had passed when the number of worm eggs per gram of feces increased slightly. The number of parasite eggs passed by the animals in Group 2 which were treated in the last part of the experiment did not increase.

The average number of parasite eggs per gram of feces in three animals in each of the two groups belonging to Herd 2 is shown in Graph B of Figure 1. Although the number of eggs in the feces of the untreated cattle showed marked fluctuations, the same result as that obtained in the previous experiment following treatment is shown in this graph. The discontinuance of the treatment of Group 1 did not bring about an increase in the number of parasite eggs in the feces of these animals.

The average number of parasite eggs per gram of feces in six animals of Herd 3 is shown in Graph C of Figure 1. These data also corroborate the results of the experiment shown in the preceding graphs.

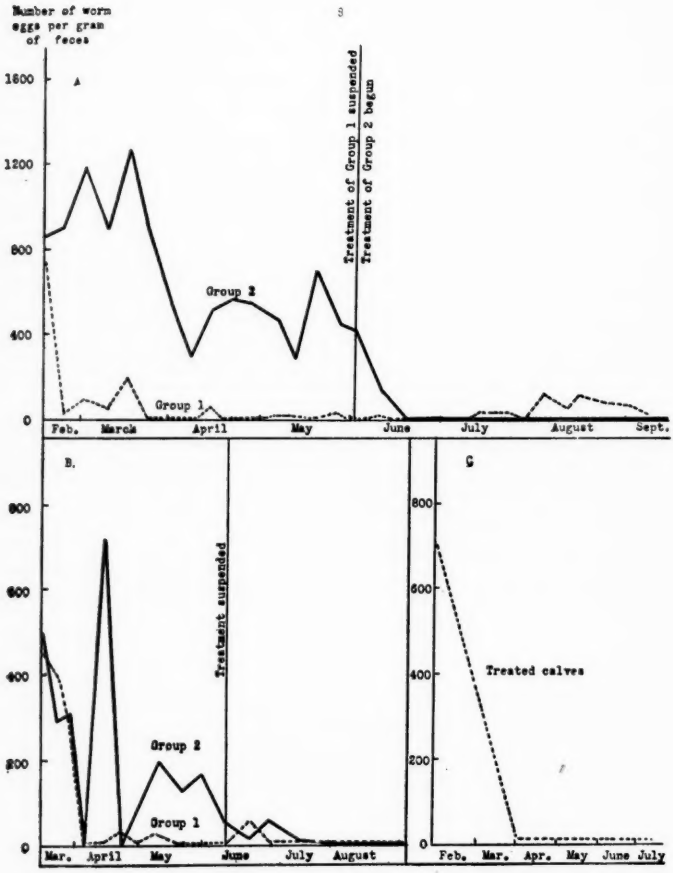

Figure 1. Average number of worm eggs per gram of feces passed by treated and untreated calves.

The data obtained from these three experiments show that the daily or weekly administration of nonconditioned phenothiazine to cattle infected with gastrointestinal parasites at the dose rate of ½ gram per 100 pounds of live weight per day decreased the number of parasite eggs passed unto the pasture by the infected animals to a negligible number.

While a general reduction in the number of parasite eggs in the feces occurred following treatment with phenothiazine, the reduction was not evenly distributed among the various species of parasites harbored by the infected animals. The eggs of the stomach worms, *Haemonchus contortus* and *H. similis*, the intestinal hair-worms, *Trichostrongylus* spp., the hookworm, *Bunostomum phlebotomum*, and the nodular worm, *Oesophagostomum radiatum*, disappeared relatively soon after the beginning of treatment. Those of the small intestinal worms belonging to the genus, *Cooperia*, the thread worm, *Strongyloides papillosus*, and the broad tapeworms, *Moniezia* spp. were not noticeably reduced in number by the treatment.

Effect of daily doses of phenothiazine on cattle and cost of treatment

The only visible sign that the animals were being treated with phenothiazine was the reddening of the urine upon exposure to air. So far as could be observed clinically and from the data obtained on the weight gained by the treated and untreated cattle, no ill effects could be detected during the entire experiment.

At the time these experiments were carried out, nonconditioned phenothiazine was selling at approximately $1.50 per pound. At this price, the daily expense of treating the animals in the three herds varied from .58 to .81 cents per head, the large figure representing the cost of treating the animals in Herd 3 where a slight excess of the compound was mixed with the feed in order to allow for losses due to the unavoidable scattering of the phenothiazine-feed mixture.

Discussion and summary

The results of the foregoing experiments show that daily doses of ½ gram of nonconditioned phenothiazine per 100 pounds of live weight administered to cattle infected with gastrointestinal parasites reduced the number of worm eggs passed unto the pasture by the infected animals. The eggs of the stomach worms, *Haemonchus contortus* and *H. similis,* the small intestinal hair-worms, *Trichostrongylus* spp., the hookworm, *Bunostomum phlebotomum,* and the nodular worm, *Oesophagostomum radiatum,* disappear relatively quickly from the feces of the treated animals. The eggs of *Cooperia* spp., *Strongyloides papillosus,* and the broad tapeworms, *Moniezia* spp., were not markedly reduced in number by this treatment. These results confirm those of Porter, Simms, and Cauthen (1941) showing that phenothiazine has little effect on the last three parasites mentioned. The dose rate used in these experiments compares favorably with that suggested by Shorb and Habermann (loc. cit.) for the prevention of the development of nematode larvae in the feces of sheep.

Acknowledgements

The writers are deeply grateful for the very helpful cooperation of Mr. Sergio Dávila, Mr. W. H. Wildman, and Dr. Morales Otero, who permitted the use of their cattle for these experiments.

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A NEW SPECIES OF PHLOEONEMUS FROM PUERTO RICO (COLEOPTERA: COLYDIIDAE)

By

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In a small collection of Coleoptera received for identification from L. E. Martorell the following new species was found.

Phloeonemus martorelli, new species

Oblong-elongate, rather strongly flattened, not distinctly pubescent, dark reddish brown, the antennae and palpi slightly paler.

Head broad, flat, sides dilated, the dilation extending backward to middle of eyes, broadly, vaguely depressed on each side toward eyes, obtusely carinate above eyes, the carina extending from posterior fourth of eye to a short distance in front of eye; surface very finely, densely granulose, finely, shallowly punctate anteriorly, finely, densely, irregularly reticulate porteriorly.

Pronotum strongly transverse, much wider than head, widest near posterior angles; sides slightly rounded, nearly parallel along basal half, vaguely converging anteriorly, the margins finely crenulate; apical margin deeply emarginate, broadly rounded and thickened at middle; apical angles projecting and rather acute; base slightly arcuate at middle, vaguely sinuate on each side; posterior angles obtusely rounded; disk moderately convex, broadly flattened toward lateral margins, with three obtusely rounded, longitudinal costae on each side of middle, median one extending from base to apex, abruptly bulging externally at middle and connected posteriorly to the second costa, which extends backward to base, and the third costa vaguely sinuate, extending from base to apex; surface rather coarsely, densely granulose, the granules very irregular in shape, and contiguous at some places.

Elytra subequal in width to pronotum; sides parallel to apical fourth, then arcuately converging to tips, which are conjointly broadly rounded, the lateral margins acute and vaguely crenulate. Each elytron with five sharply defined, longitudinal costae; sutural and second costae extending from base to apex; third and fourth costae extending from base to near apex; fifth costa extending backward from humerus, and connected to lateral margin near apex; intervals between costae (except lateral one) with two rows of rather coarse punctures, separated from one another by about their own diameter, and the interval between punctures in each row with a narrow, longitudinal carina exending from base of one puncture to apex of following puncture, the interval between rows of punctures nearly smooth.

Abdomen beneath more or less irregularly imbricate-puncture; prothorax coarsely, transversely rugose.

Length 4.7-6 mm., width 2-2.7 mm.

Type locality. — Guánica, Puerto Rico.

Type and paratypes. — In the United States National Museum, No. 56541. Paratypes in the collection of L. F. Martorell.

Described from ten specimens (one type) all collected at the type locality, January 31, 1940, on the gummy exudations on the trunks of *Zanthoxylon flavum* trees, by L. F. Martorell.

This species is closely allied to *Phloeonemus haroldi* Reitter, described from Cuba, but it differs from that species in being larger, in having the longitudinal costae on the elytra not interrupted, the carinae above the eyes obtusely rounded on the tops, and the costae on the pronotum more distinct with the lateral one on each side vaguely sinuate.

A NEW AMBLYCERUS AFFECTING SEEDS OF PROSOPIS CHILENSIS IN PUERTO RICO AND HISPANIOLA

By

JOHN COLBURN BRIDWELL

United States National Museum
Washington, D. C.

Among the insects found affecting the seeds of forest trees in Puerto Rico by L. F. Martorell is a new species of the bruchid genus *Amblycerus* here described and named in his honor. The same species has been intercepted in material originating in Haiti and the Dominican Republic by inspectors of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

AMBLYCERUS MARTORELLI Bridwell, new species

Nearly the size and habitus of *Amblycerus robiniae* (Fabricius) (=*Spermophagus haffmanseggi* of the Leng Cataolgue not of Gyllenhal) but lacks the black integumentary areas of that species, is smaller, and has differently shaped pronotum and scutellum, shorter calcaria and numerous differences in sculpture. Reddish brown with appressed pubescence, uniformly yellowish cinereous above and pale beneath, nearly evenly disposed and partly concealing the surface sculpture, without blackish hairs except for single black hairs in the larger punctures of pronotum and elytral intervals. Pectus often infuscate, sternites with ill-defined paler margins.

Length, 5-6.5; width, 3-3.5 mm.

Eyes emarginate for about one-fourth their length, coarsely faceted, strongly convex, projecting about one-half their width; front at clypeus separating the eyes by about one-half their width, strongly punctulate, without coarser punctures, with only a slight vestige of a glabrous unpunctured line near clypeous, mentum without punctures. Antennae with 3 narrow joints at base, joints 2 and 3 together about as long as joint 1 and longer than 4, joints 4-10 longer than broad, compressed and expanded with inner apical angles produced, these joints subserrate and closely applied to each other.

Prothorax about as broad at base as the elytra, transverse, dorsum coarsely and rather densely punctured on the sides, a broad longitudinal median area without these punctures, impressed lines along lateral margins above and below ending far from the anterior margin, flanks without coarse punctures; prosternum very narrow between the coxae, extending slightly beyond them, slightly expanded and truncate at apex, not received in any special structure of mesosternum; this nearly vertical, flat, hairy, and truncate at apex, meeting metasternum at an obtuse angle; metasternum not gibbous, with apex set off by the impressed marginal line; scutellum parallel sided, oblong-subquadrate, pointed at apex, emarginate on either side of the point, the lateral angles rounded.

Elytra about thrice as long as prothorax, widest near middle, broadly, obliquely, subtruncately separately rounded at apex, intervals 2, 4, 6, and 8 slightly costate giving a slight vittate effect, intervals dotted with fine darkish punctures each bearing a single black decumbent hair. Pygidium nearly plane, oblique, about as broad as long, margins converging in a convex curve to the broadly truncate or rounded apex, disc infuscate, margins pale, a pale pubescent longitudinal line, punctured except for a small subbasal area on either side. Last sternite longer than the preceding in female, shorter than preceding in male.

Hind coxa with about 30 irregularly disposed, rather coarse shallow punctures on the large pubescent area and with several fine strongly impressed punctures on the glabrous shining area near the insertion of the trochanter. Inner and outer carinae of ventral margin of hind femur obsolescent on basal half, inner carina unarmed as is usual in *Amblycerus*. Calcaria of hind tibia but little unequal, as 5 to 4, longer outer calcar not half as long as basal tarsal joint; outer dorsal surface of hind tibia with a line of closely placed punctures extending from base to apex, ventral surface with two lines of punctures where it meets the outer and inner faces in an even curve, apex obliquely truncate with about five rounded teeth at dorsal apex.

Described from 41 specimens in the United States National Museum, reared from pods of *Prosopis* (or *Neltuma*) *chilensis*, labeled as follows:

Type a male, also 16 female and 8 male paratypes: from seed-pods of *Neltuma juliflora* (= *chilensis*), P. R. Acc. No. 785-40, Guánica, PUERTO RICO, 12-5-40, L. F. Martorell.

Five female and 3 male paratypes, from mesquite, HAITI, 27-9-35, N. Y. 47420.

Six female and 2 male paratypes, from *Prosopis chilensis*, DOMINICAN REPUBLIC, Chicago No. 1126, 21-xi-41. These were submitted by the Division of Plant Quarantine, Bureau of Entomology and Plant Quarantine. U. S. N. M. Type No. 56542.

The transverse pronotum, coarsely punctured laterally and finely punctulate on a broad median area; the impunctate mentum and flanks of pronotum; the very narrow prosternal process slightly wider at apex; the hind tibia with dorso-lateral line of punctures and with subequal calcaria less than half as long as basal tarsal joint; these characters separate *A. martorelli* from *A. robiniae, A. hoffmanseggi,* and most species of *Amblycerus* known to me. *A. hoffmanseggi* (Gyllenhal), *A. nigromarginatus* (Motschulsky), *A. obscurus* (Sharp), and *A. baeri* (Pic) may be one species judging from the descriptions, and the species I have doubtfully determined as *A. hoffmanseggi* resembles *A. martorelli* closely but the calcaria are more unequal in length, the longer outer one being one and one-half times as long as the inner and more than half as long as the basal tarsal joint and the mentum is distinctly punctured. It is found from Mexico to Brazil breeding in the seeds of several species of *Cassia* (sens. lat.). From *A. piurae* (Pierce), which breeds in *Prosopis* in Peru, *A. martorelli* differs in coloration, no part of its body and appendages being as dark as the nearly black antennae, legs, disc of elytra, breast, and sternites of *A. piurae.* They are not mere variants since the median lobe of the aedeagus in *martorelli* is much more expanded near apex and more nearly parallel sided in *piurae.* Typical examples of *A. testaceus* (Pic) from the Chaco of Argentina are very unlike *martorelli,* but I have seen associated with these entirely testaceous individuals others resembling *martorelli.* These have, however, only a few rather fine punctures on the sides of the pronotum, only visible when the pubescence is removed. Its host plant is still unknown, but seems to be neither *Prosopis* nor *Cassia.*

Amblycerus martorelli has been compared with all the West Indian species of *Amblycerus* in the United States National Museum, including nearly all the described species and numerous undescribed forms, and it resembles none of them at all closely. Its presence in Puerto Rico and Hispaniola seems certainly the result of accidental introduction from some unknown region of North or South America where it lives at the expense of *Prosopis chilensis.* This plant occurs in the West Indies only where it has been introduced. For the most part such introductions have occurred in recent years, but in Jamaica before the middle of the eighteenth century.

A NEW ENCYRTID PARASITIC IN THE EGGS OF HESPERIIDAE

By

A. B. GAHAN

United States Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine

Specimens of an encyrtid reared from eggs of *Prenes* sp. in Puerto Rico, recently submitted for identification, appear to represent a new species.

OOENCYRTUS PRENIDIS, new species

This new species is apparently most closely related to *Ooencyrtus latiscapus* Gahan but may be distinguished at once by the much narrower antennal scape of the female and by the wholly yellowish-testaceous legs. The color of the legs is similar to that of the legs of *submetallicus* (Howard) but the antennae are much shorter and more strongly clavate and the sculpture on frons and scutellum is shallower and less distinct

Female.—Length 0.75 mm. Head as broad as thorax, rather deeply concave behind; fronto-vertex moderately narrow, the distance from upper end of scrobal depression to posterior margins of vertex equal to about one and one-half times the shortest distance between the eyes; frons and vertex with distinct but shallow reticulate-punctate sculpture; face and cheeks indistinctly sculptured, nearly smooth; ocelli in a slightly obtuse triangle; scrobal cavity triangular, nearly acute dorsally; mandibles with three very short, blunt teeth; eyes with very sparse, inconspicuous pile. Antenna relatively short, strongly clavate; scape slightly thickened medially, approximately four times as long as broad; pedicel nearly twice as long as broad and a little less than one-third the length of scape; funicle gradually thickening from base toward apex, each segment with an irregular whorl of hairs which are a little longer than the segments from which they originate; first funicular segment narrower than the pedicel and a little longer than broad; remaining segments about as long as broad; club indistinctly 3-segmented, nearly twice as broad as sixth funicular segment, elongate

ovate in outline, approximately as long as the four preceding funicular segments combined and clothed throughout with much shorter and finer hair than on the funicle.

Thorax only a little longer than broad, convex dorsally; pronotum very short, mostly concealed from above; mesoscutum much broader than long, weakly reticulated, and moderately clothed with short, brownish hairs; scutellum moderately convex, about as long as mesoscutum and with similar sculpture on basal two-thirds, the apical third smooth and shining, a pair of rather long, erect bristles at extreme apex and a few shorter hairs scattered over the basal sculptured portion; propodeum very short, smooth and shining; mesopleuron nearly smooth. Legs normal. Forewing a little less than two and a half times as long as broad, extending far beyond apex of abdomen; marginal vein slightly longer than broad and not quite so long as stigmal vein; postmarginal vein about as long as marginal, indistinct; discal cilia basad of the hairless streak distinctly sparser and coarser than those distad of it.

Abdomen much broader than long, subtriangular, as broad as thorax but much shorter, its surface without distinct sculpture; ovipositor not exserted.

Head and dorsum of thorax black with a distinct metallic luster, the mesoscutum usually with a slight greenish tinge, and the scutellum bronzy basally but with the smooth apical portion distinctly greenish; under side of thorax dark brownish; legs, including all coxae, yellowish testaceous; wing hyaline; tegulae concolorous with mesoscutum; abdomen brownish black. Antennal pedicel and segments 3-6 of the funicle more or less dark brownish; scape, first and second funicular segments, and club pale testaceous.

Male.—Lenght 0.75 mm. Less robust than the female; fronto-vertex broader than long; ocelli in a distinctly obtuse triangle; ocellocular line approximately equal to half the diameter of a lateral ocellus; scrobal cavity rounded dorsally. Antenna long, not clavate; scape not thickened; pedicel about as broad as long; funicular segments all of about the same width as pedicel but longer, subequal to one another or increasing very slightly in length from first to last, the first segment about one and a half times as long as broad, the sixth sometimes a little more than twice as long as broad, each segment clothed with hairs which are somewhat longer than the segment bearing them; club about as long as two preceding segments combined and scarcely broader than funicle. Abdomen about as long as broad, rather sharply triangular. Antenna nearly uniformly pale yellowish,

the pedicel and base of scape more or less fuscous; head, thorax, and abdomen black dorsally with a distinct coppery tinge; underside of thorax brownish black; legs yellowish testaceous, the coxae, hind femora, and basal half of hind tibiae infuscated with brownish. Otherwise like the female.

Type localities.—Salinas and Quebradillas, Puerto Rico.

Type. — U. S. National Museum No. 56540.

Described from 18 females (1 holotype) and 8 males (1 allotype) reared from eggs of *Prenes* sp. on sugarcane at Salinas, Puerto Rico, by L. F. Martorell in June 1942; also 2 females and 2 males reared at Quebradillas, P. R., Oct. 20, 1938, from *Prenes* sp. eggs.